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AUTHOR Eastwood, Lester F., Jr.
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ABSTRACT

The "intelligent videodisc"--a combination of advanced microprocessor, display, and storage technology--holds the potential for developing into a powerful instructional delivery system. In an inexpensive package, it could combine advanced computer-aided instruction (CAI) software power and display capability for audio, video, and textual programming. Although it is attractive technically, this system's real contribution will be that CAI will fit the institutional structure of education for the first time. In contrast to existing CAI systems, this small-scale device could be purchased locally. Another unique attribute of this technology is its potential attractiveness to consumers. Despite these advantages, this new technology will face some of the same traditional barriers that have doomed other systems. It is likely that many teachers will retain their unwillingness to innovate using technology. Tight budgets will remain because of shrinking student populations and voter apathy. High cost might restrict software availability. This paper could serve as a platform for a discussion of needs and opportunities for a Federal role in promoting educational utilization of this system. (Author/VT)

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# MOTIVATIONS AND DETERRENTS TO EDUCATIONAL USE OF "INTELLIGENT VIDEODISC" SYSTEMS

by

Lester F. Eastwood, Jr., Ph.D.
Associate Director
Center for Development Technology
Associate Professor
Departments of Technology and Human Affairs and
of Electrical Engineering
Washington University
St. Louis, Missouri 63130

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# MOTIVATIONS AND DETERRENTS TO EDUCATIONAL USE OF "INTELLIGENT VIDEODISC" SYSTEMS

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## ABSTRACT

The "intelligent videodisc" - a combination of advanced microprocessor, display, and storage technology - holds the potential for developing into a powerful instructional delivery system. In an inexpensive package, it could combine advanced computer-aided instruction (CAI) software power and display capability for audio, video, and textual programming. Attractive technically though it is, this system's real contribution will be that CAI will fit the institutional structure of education for the first time. In contrast to existing, large-scale CAI systems, this small-scale device could be purchased locally, e.g., by one teacher or administrator. Another unique attribute of this technology is its potential attractiveness to consumers. Acceptance in the home may speed acceptance in schools.

Despite these unique characteristics, this new technology will face some of the same traditional barriers to innovation in education that have doomed other systems. It is likely that many teachers will retain their unwillingness to innovate using technology. Tight budgets will remain because of shrinking student populations and voter apathy. High costs might restrict software availability.

This paper investigates these and other driving forces and barriers to use of the "intelligent videodisc" as a personal instructional delivery system. The paper can serve as a platform for a discussion of needs and opportunities for a Federal role in promoting educational utilization of this system.

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# 1. INTRODUCTION.

One trend in computer technology over the last fifteen years has been to reduce the size, cost and complexity of computers while retaining most of their power. Examples today are minicomputers and microcomputers of high capability. It is likely that this work will continue; estimates are that by 1985 a sophisticated computer with TV display could be contained in a package about the size of an electric typewriter. This computer, connected to a video disc, could have both impressive computing power and a read-only memory of huge capacity. By 1985 the total cost of such a package might be about $1500 - $2000.

For education, the potential capabilities of this combination of devices are impressive. For example, the "intelligent videodisc" - as we term the system - could have PLATO IV software power and a cursor and a typewriter to allow interaction equivalent to PLATO's. Many PLATO-like programs could be stored on a single video disc, and discs should cost no more than $10.00 or so if demand is sufficient. In addition to computer-aided instruction, the system could also support still-picture or motion-picture television, and normal or compressed audio. Moreover, the large and powerful programs stored on the video disc could be augmented by individualized programming, perhaps submitted to the system on magnetic cards. Therefore the combination would have PLATO software power and TV, audio, and interactive capabilities - power significantly greater than PLATO at a cost much less than one PLATO terminal.

This advance may look attractive technically, but its major contribution will be that for the first time, computer-aided instruction will fit the institutional structure of education. Most sectors of our educational

system possess a very segmented structure with decision-making scattered, not centralized. This structure is especially evident in the largest sector, primary and secondary education. The small scale of the new technology allows individual educators, who are innovators or entrepreneurs, to decide to use the technology. Unlike present large-scale CAI systems, it does not require district-level amounts of financial support.

Another unique attribute of this system which will enhance the likelihood of its use in education is its potential attractiveness to the consumer market. The systems might be purchased for use in homes as game-playing devices, as monitors for home energy systems, or as computers to run specialized programs (e.g., for income tax, or budgeting). Once the systems are accepted in the home, they then might be more easily transferred to the schools. This is the history of the hand-held calculator, for example.

However, despite its many unique characteristics, this new technology will probably face some of the same traditional barriers to innovation in education that have doomed other systems. It is likely that teachers will retain their unwillingness to innovate using technology. This unwillingness may be caused by fear of being replaced by machines, by lack of teacher training in using technology, or by the lack of a reward structure in education for innovations of this kind. In addition, education's budget will remain tight. Student populations continue to shrink, and bond issues and real estate taxes are finding voter opposition. Many educators will prefer to use their limited funds in other ways.

An additional barrier faced by computer-aided instruction systems today will probably, but not certainly, continue to be faced by this new

technology. This barrier is the availability of software, which can be overcome only by large-scale market aggregation. Software for computer-aided instruction is expensive to produce now, and it may be more expensive for the new system with its greater capabilities. This expense must be shared by a large population of users to reduce per user cost. Thus, only if software attractive to a large market can be produced in enough quantity to support a software production industry will this system see widespread use.

However, as stated earlier, this system may be attractive to the consumer market for use at home. Extensive use in the home would develop a software industry which could then branch out to serve education. If these developments occur, this system would be a unique CAI system, since no system existing has served a wide market of home users, so its probability of success might be higher.

A software industry would also benefit from the fact that royalties on discs, which are hard to copy illegally, should be as easy to assess as they are on stereo recordings. This factor should make the medium attractive to authors.

Because this system is evolving so quickly of its own accord, it may be important that the federal government act to influence its development to insure that education can take advantage of the system. For example, without federal influence the system might develop to serve only commercial interests. If this trend seems likely, then the federal government might speed educational use of the system — by installing demonstration projects, funding research on software development, or training teachers, for example. On the other hand, it may be that the government might just as well adopt a hands-off policy.

This paper provides background necessary to begin to plan federal action, if any is needed. The paper investigates driving forces leading to, and barriers deterring, the system's development and acceptance in education. We focus on the barriers, because driving forces are already well-described in a large and optimistic literature on education's "need" for technology. Moreover, the barriers are imposing. They have so far managed to withstand any large-scale incursion of technology in education.

The paper contains two major sections — one on motivations; the other, on deterrents. In keeping with the philosophy just described, the motivations section is brief — an overview of what has been written on the capabilities of CAI and of the "intelligent videodisc" system, the possible educational markets for technology, and the commercial forces which are motivating development of the system.

The second section, on barriers, divides the forces which will deter acceptance of the "intelligent videodisc" system into three types: educational, economic, and technical. Of course, any division like this suffers from the fact that many barriers exhibit, say, both educational and economic aspects. However, it helps the exposition.

The educational barriers, in this author's opinion the most critical, have many facets. We investigate deterrents due to attitudes and traditions, difficulties in marketing to educators, institutional and legal constraints, inappropriate facilities and staffing, failings of educational research and development, and the difficulties faced by educational software production and distribution industry. Some of these aspects are complex enough to be subdivided further. For example, statutes and practices in accreditation, certification, state aid to

schools, approval of instructional materials and privacy erect legal barriers to technological innovation in schools.

As imposing as the educational barriers appear, they are only one aspect of difficulties faced by the new system. Perhaps equally critical are the economic obstacles. The second part of the section on barriers considers these economic forces, focussing on the likely high software costs, cost-reducing engineering breakthroughs needed, and on the problems that still face the videodisc in the commercial market — competition, lack of standardization, and copyright battles.

A third, less imposing, dimension is technical. The final part of the barriers section lists some engineering puzzles to be solved: standardization, reliability, read/write capabilities, and the user-machine interface, for example. These problems are far from insurmountable, however, given sufficient motivation. In this author's view, the place in which most engineering attention is needed is in cost reduction, an issue covered in the previous section.

## 2. DRIVING FORCES

The "intelligent videodisc" may become one of the most important developments in educational technology. Gaining great versatility from its capability to perform as a display device for instructional television and CAI, it combines the potential for commercial success with the promise of low unit cost in a way no earlier CAI system matches. But will it succeed where other systems have failed? Let us consider some of the factors which may lead to a demand for the system.

### 2.1 EDUCATIONAL "NEEDS" AND "MARKETS"

In its 1972 report on instructional technology in higher education (1), the Carnegie Commission surveyed college faculty members' attitudes on instructional technology. The professors were generally optimistic. They believed that by 1980, student-initiated access of audio-visual technology would be commonplace in colleges; that 1990 would see "routine" use of CAI and programmed instruction; and in the year 2000, students would enjoy extensive exposure to sophisticated CAI, while teachers would customarily employ computer-aided course design. Business and education professors were the most optimistic, and engineers and scientists nearly as hopeful, but professors in the liberal and fine arts did not share their enthusiam. Other attempts at forecasting acceptance and utilization rates of technology, made at about this same time, shared the optimism to a greater or lesser degree (2, 3).

Despite these aspirations, the Carnegie Commission and others apparently realized that the tradition-bound established institutions are unlikely to be the prime movers in employing technology:

> The most significant advances will be generated by emerging institutions and extramural educational systems. (1)

In the same vein, a wide-ranging study of opportunities for technology in all sectors of U.S. education (4) concluded that greater promise lies in sectors outside the mainstream: career education; adult and continuing professional education; early childhood education; education for the handicapped; and special services for minorities. These sectors, not well-served by traditional methods, are sometimes the focus of special federal interest. They are also less bound by tradition and law than primary, secondary, and some higher education.

Kellock (5) notes that the demand for independent study is an especially exciting opportunity for technology. Three factors contribute to this demand, he states: 1. the need to offer higher education to wider constituencies, 2. colleges' need for older students as the 18 to 21 year old student population declines, and 3. the demand by these older students to individualize instruction and schedule it flexibly.

Colleges are responding. Kellock (5) states that the National University Extension Association lists two thousand correspondence course titles offered by 85 institutions. Moreover, in the six years from 1969 to 1975, participation in adult education increased 31%. (5) In addition, a key point made by this author is that even faster growth is hindered by the lack of interaction in correspondence courses.

Exciting though these statistics for independent study may be, we must remember that more than eighty percent of our country's sixty million students are enrolled in traditional primary and secondary schools. (4) Even here some promise exists. A recent Corporation for Public Broadcasting study has found that, in the 1976-77 academic year,

fifteen million students — about one third of the elementary/secondary population, received some instruction by television (6).

## 2.2 THE EDUCATIONAL POTENTIAL OF TECHNOLOGY

In addition to considering educational "markets" or "needs," many authors have written about the educational potential of various technologies. Of these authors, advocates of CAI often wax most enthusiastic. Writing about a related interactive teaching technique, programmed instruction, Enrich states:

> Students learn best when their minds are absorbed and active... the message is: keep the student's mind active and responding, keep him mentally ducking and weaving .... (7)

Bork (8) and Anastasio (9) are two of many authors who point to the numerous ways that CAI might benefit education. Some are: 1. CAI can offer increased effectiveness, individualization, and equality of opportunity. 2. It offers budding engineers or natural and social scientists the opportunity to work on realistically complex problems, and it can create experiences that aid understanding (e.g., in quantum mechanics). 3. CAI provides a high level of interaction and immediate feedback. The student benefits from a more intense experience, while teachers find course revision easier and evaluation more accurate. 4. One can schedule instruction flexibly, serving busy adults and freeing students of all ages from the lockstep progress that traditional education dictates.

Notwithstanding this impressive potential, CAI has seen little day-to-day use. A variety of reasons cause this slow growth, and we consider them in detail later. Some of the most critical obstacles (9) have been high unit costs, lack of a convincing demonstration, a sluggish

commercial market outside of education, lack of high quality software, and concern over reliability. It is in these areas especially that many authors see the "intelligent videodisc" as a bright new hope.

## 2.3 NEW HOPE WITH THE "INTELLIGENT VIDEODISC"

For example, Whitney (10) states that hardware costs have plunged precipitously in the last decade, leaving the cost of computer ownership as the primary stumbling block. In "cost of ownership," he includes charges for training, software purchase and development, maintenance, downtime and supplies. Designs that make the machine easier to use cut the high labor costs involved in most of these activities, and distributed computing enhances reliability, saving on downtime and maintenance. The "intelligent videodisc," says Whitney, is such a design. He predicts that every school will own the system in the 1980's.

Echoing this optimistic view, Seidel (11) notes predictions by Leuhrmann that by 1985, electronic storage of information will be far less expensive than using the print media. Leuhrmann estimates that one billion dollars worth of disc display technology will be in homes by 1985.

Recognizing this commercial potential, many authors have been equally enthusiastic about the "intelligent videodisc" system's educational potential. Bork claims:

> a teaching dialog stored on a videodisc would have full capability of handling very complex computer logic, making sizable calculations, ... show(ing) video sequences ... or slides ... or present(ing) audio messages. (12)

Schneider (13) echoes this enthusiasm, listing a number of possible educational uses in order of increasing complexity: 1. the educational television library with freeze-frame capability, 2. a replacement for

slide and tape shows, and 3. interactive applications, from the simple machine accepting multiple choice response, to slightly more complexity allowing branching among CAI program routines, and finally to the most complex, fully interactive CAI/educational television system.

Another widely recognized feature of the system is its likely attractiveness to authors. Bork (12) notes that the initial manfuacture of videodiscs is expensive, allowing little likelihood of "pirating". Luehrmann expands on this point, writing:

> 1. Like a book, video disc has a low unit cost in mass production.
>
> 2. Like a book (before xerography), the cost of private copying is far more than buying a published disc. Blank videotape is five times as expensive as a disc.
>
> 3. Because of (1) and (2), legal copyright protection will be enforcable for disc material -- the underlying premise being that cheap copying renders copyright laws unenforcable.
>
> 4. Like a book, unit disc prices are so low that the decision to buy is decentralized and diffuses out to the individual person. The situation with films should be contrasted with this one. Only institutions buy films.
>
> 5. Because of (3) and (4), discs will be attractive to authors as a medium of publication of their courseware. Substantial and protectable royalty revenues are possible and will not depend entirely on satisfying the needs of traditional education institutions. (14)

As a final optimistic note, Bork sees a trend in CAI development which leads directly to the videodisc: "It seems very likely that the field will be dominated by graphics in the future." (15)

However, lest we get carried off by this sweet river of enthusiasm, let us end this section and introduce the next with a quotation from the Association for Supervision and Curriculum Development:

What emerges from this consideration of the system of education in the United States is an enormous capacity to absorb change while not changing at all. (16)

# 3. BARRIERS

This section discusses obstacles to educational use faced by the "intelligent videodisc" system. After Anastasio (9), we classify these barriers under three headings: educational, economic, and technical. Though not mutually exclusive, these headings do provide a structure for analysis. For example, the order in which they are listed is important; in general, prevailing opinion is that the educational barriers are most critical - hardest to overcome - the economic, second most critical; technical, third (9, 11).

We attempt to order by importance each of the three sections of this chapter. For example, under "educational" barriers, we list obstacles erected by laws and institutions first, attitudes and traditions next, then facilities and staffing, marketing to education, software production, and educational research and development. Under "economic" obstacles, we first discuss costs of the system, followed by a description of the present disarray in the videodisc consumer market, including the copyright fight. Finally, a brief section on technical barriers identifies engineering problems to be solved.

Admittedly, one can quibble with details of this ordering. However, we plunge ahead with it. Its value will be to bring attention to critical areas.

## 3.1 EDUCATIONAL OBSTACLES

### 3.1.1 Laws and Institutions

In 1968, an era of unsullied technological optimism, the Committee for Economic Development boldly stated:

> We are convinced that reconstruction of instructional staffs, instructional patterns, and school organization must lie at the heart of any meaningful effort to improve the quality of schooling in this country. (17)

This statement is probably true. Therefore, it points out a major stumbling block to innovation in education: for reasons like perceived self-interest, conservatism, fear of failure, and so on, certain elements of the structure of our educational institutions are hard to change. This section examines those elements that could deter acceptance of the "intelligent videodisc."

3.1.1.1 Certification and Accreditation

State governments have the authority to license, or certify teachers. Heinrich and Ebert point out that states also generally appropriate an additional power:

> The state does not prescribe the number of licensed physicians, plumbers, barbers, etc., a town must have, but it often assumes the authority to specify by some formula the number of certified teachers a school district needs. (18)

This definite numerical requirement can discourage introduction of technology. Slapping an immovable lower bound on the number of certified teachers removes much of the economic incentive to innovate. This can often be a killing blow; as Miles notes:

> In the absence of good measures of output, educational organizations tend to stress cost reduction, since other potential rewards of innovation remain only vaguely seen. (19)

Even when the pupil/teacher bounds have been satisfied, certification rules have been used by teacher associations to challenge the introduction of educational technology. Heinrich and Ebert cite the example of

Addison Trails High School in Illinois. The school used television and a paraprofessional to teach a typing class for which no certified teacher was available. With teachers' association prodding, the state notified the school that it legally prohibited the use of non-certified instructors "unless under the immediate supervision of a certified teacher." Immediate supervision was interpreted to mean in the same classroom. (18) The dispute ended in a compromise, never going to court, so it was never subject to formal legal interpretation. By compromising, the state avoided setting a legal precedent. Presumably, it is still free to decide either way in similar situations.

The key issue, as brought out by this example, is the definition of supervision (18). Should the certification requirement apply to the teacher on the TV display, the individual in the classroom, or both? How should pupil/teacher ratios be calculated in such a situation?

As disenchanting as this situation may sound, it can change, at least in some of the freer-thinking states:

> The California law that spells out distribution of state aid to community colleges has changed over the years from direct supervision to indirect supervision of paraprofessionals by certified staff. A great deal of the pressure for change was the installation of audio-tutorial techniques and televised instruction. In both, the efforts of certificated personnel are incorporated into the materials ... (18)

Much of the same thinking evident in teacher certification rules appears in standards for schools set by regional accrediting associations. These standards typically recommend a pupil/teacher ratio for schools. Any deviation from the standards requires much explanation. Departures occur, and they are often approved. However, as Heinrich

and Ebert put it, "technologically-based instruction will be questioned while the same instruction delivered by a classroom teacher will not," (18) greatly increasing the amount of paperwork necessary to justify this type of instruction.

Accreditation associations also value input more than output in another way: by setting standards for time spent in class. Programmed instruction, in which time spent is variable, does not fit this standard (18). Neither, presumably, would CAI delivered by the "intelligent videodisc." A school superintendent, R. M. Finley, writes that CAI "satisfies no standards as written" (20), a concern echoed by many other authors, e.g. (7).

Regional accrediting associations are voluntary, and their dicta appear at first glance to be followed simply because schools want to be accredited. But sometimes more than that is involved. According to Heinrich and Ebert, "the Federal government is now using the accreditation association's evaluations as the basis for distributing occupational and vocational training funds." (18) Thus, ironically, the Federal government is supporting technological innovation on the one hand, and strengthening defenders of the status quo on the other!

Another type of accrediting body, the state accreditation agency, always has the power of the dollar behind its decisions. The evaluation criteria used by these agencies are incorporated in state school aid formulas.

3.1.1.2 State School Aid

Although on the face of it dispensed on a per pupil basis, state financial aid to schools has historically been a means for states to

enforce their pupil/teacher ratio certification regulations. Districts could maximize their aid with a certain ratio. Deviations were punished. Thus, these formulas were an economic disincentive to the use of instructional technology. (18)

These rules are now in flux. To guarantee fair support of all students, the courts are demanding that all references to staffing requirements in state aid rules be dropped, and fourteen states have commissioned extensive reviews of their laws. However, it is likely that the new laws will meet court challenges (18), so the final form of the state aid laws is still in doubt.

3.1.1.3 Collective Bargaining

As the power of state aid declines, teacher associations are taking over as new champions of the status quo. As Neben puts it, "collective bargaining and contracts (are acting) as legal locks against changed functions." (21) The National Education Association publishes model contracts to be used as goals by local negotiators. Unsurprisingly, these models push strongly for labor intensive staffing. (18)

Since the NEA has made its desires clear, the question that remains is: how likely is it that the NEA will get what it wants? According to Heinrich and Ebert,

> The growth of public employer-employee collective bargaining has been slowed by fears concerning the effects such bargaining will have on the ability of the public employer to formulate public policy... The various state statutes have handled this problem of educational policy differently. At one extreme, the public employer is obliged to "meet and confer" on a non-binding agreement. At the other extreme, the statutes apparently authorize wide-open negotiations on a non-binding contract. (18)

These authors cite California as a "meet and confer" state; New York, "wide-open"; others, in between the two extremes.

Despite these differences, however, the role collective bargaining plays in setting educational policy is substantial in every state (18). R. M. Finley, a superintendent of schools writing about technological innovation, complains that "teachers are demanding more voice in curriculum direction, evaluation, and ... administration." (20) He decries the power held by teachers and boards of education. These groups are conservative and form a substantial roadblock to innovation.

Heinrich and Ebert note that teacher groups try to negotiate monetary penalties from districts when pupil/teacher ratios go too high. Boards of Education sometimes naively agree. A Trenton, New Jersey agreement reads:

> Immediate steps will be taken to assure that no academic class will be maintained at a level in excess of 30 pupils for the school year 1970-71. (18)

When the school board failed to fulfill this promise, the teachers filed a grievance and won.

Although the ratio requirement would be a major stumbling block in any attempt to justify a technological innovation, it is not the only roadblock that teacher's associations have managed to erect. Other possibly anti-technology agreements in collective bargaining are: 1. certification requirements for school staff, 2. a strong role for teachers reserved in any innovation, and 3. a voice for teachers in approving purchase of "instructional materials." (18) One study has shown that union negotiators fear instructional media (22). In summary, union power and attitudes make any major innovation difficult.

3.1.1.4 Lack of Faculty Incentives

The teacher activism just described is giving teachers greater strength. One way advocates of innovation might take advantage of this new teacher power would be to offer teachers incentives to innovate. Unfortunately few schools do. Miles writes that primary/secondary faculty have little reason to introduce change,

> since educational products do not have immediate economic payoff, ... educational practitioners are paid on the basis of longevity and personal educational attainment rather than on net output, [which is] very difficult to measure. (19)

Lack of incentive for faculty to develop courseware is a reason often cited by authors explaining the poor success record of CAI. The Carnegie Commission recommends that faculty be given release time, promotions, salary improvements, and training in the use of technology to encourage software development. (1)

3.1.1.5 Decentralized Management of Education

The abstract of this paper hails the "intelligent videodisc," a small, standalone CAI system, as the first powerful CAI delivery device that fits the segmented institutional structure of education. In fact, this statement may not be accurate. Even with standalone systems, many tasks will probably remain centralized; for example, software maintenance, programming, and teacher training. (9) (15) Therefore, the intelligent videodisc may still face difficulties caused by the segmented structure of education.

Authors describing CAI's failure to make significant inroads cite this problem of segmentation. A technologist decries the "inability of educational institutions to standardize" (11), while an educational

administrator notes education's "diversity" and "lack of coordination." (20) Neben claims that the "need to involve interinstitutional, interstate, and intrastate organizations in planning and implementation" has caused many new technological initiatives to run aground. (21) As we mention in our section on Software Production, this activity in particular may suffer.

3.1.1.6 Privacy

Contemplation of the idea of a National Data Bank in the 1960's gave rise to concern about privacy. This concern stimulated both federal and state legislation seeking to protect individuals and to limit access to educational records. (23)

Any interactive system for education, the "intelligent videodisc" included, holds the potential for abuse of privacy. Authors speculating about how the educational videodisc-computer might be designed mention that data on student performance could easily be gathered for central evaluation, either by attaching the system to a central computer (10), or by writing it on a special magnetic area on the disc for later compilation (13). Some of the data thus collected may be sensitive.

For example, computer-managed instruction (CMI), a foreseeable use for the "intelligent videodisc," must have access to performance records. CMI plans students' programs individually, based on past performance. One example, cited by Lieberman and Morgan (23), is Westinghouse's Program for Learning in Accordance with Needs (PLAN), which uses data on students' previous study records, level of ability and achievement, learning style, need for supervision, and vocational interests. It also employs some information on parents. Other uses of computers in

education, such as vocational counseling and educational information systems, may access even more detailed files.

One privacy issue that arises has to do with the quality of the data. The data must be legitimate and accurate or their use will not be fair. As Lieberman and Morgan put it,

> Much of the personal information that many educational information systems find necessary to collect needs constant reappraisal for accuracy, timeliness, and relevancy. (23)

Even if the data are of high quality, a second issue remains: who gets access? The Family Educational Rights and Privileges Act (1974) gives families or post-high school students the right to inspect educational records. At the same time, it denies access to many, including federal agencies. (23)

Access through abnormal channels must also be avoided. Designers of both the "intelligent videodisc" for education and its complementary systems must protect the data these devices collect from theft. (23) This protection can only be built in at some cost.

### 3.1.2 Attitudes and Traditions

The institutional and legal obstacles considered above are more concrete, but nevertheless may be no more critical, than barriers due to the attitudes and traditions that have grown up about education. Institutional commitment is nearly certain to be a stronger determinant of action then details of institutional structure. Views on the traditional role of the teacher, fears about experimenting with children, and reluctance to change build bastions of conservative thought. They likely have as much effect on innovation in schools as do state controls and new union privileges. This section studies the views held by educators,

administrators, parents, government officials, and technologists, attempting to key in on how these views may throw up roadblocks in the path of the "intelligent videodisc." We begin with what the Carnegie Commission has called the "greatest single obstacle" (1) to technology, the lack of institutional commitment.

3.1.2.1 Lack of Institutional Commitment

If wide use of any technology is to occur, change is required in all facets of education, and top administrators must be the prime movers. Needed are new faculty incentives, training programs, inter- and intra-organization cooperation, and new facilities. (9) In higher education, states the Carnegie Commission, "the responsibility [for these changes] rests with the top academic administrators." (1) In primary and secondary education, with Boards of Education and teacher's associations exerting an ever-stronger and more conservative force, "the Boards will not move" without the commitment of the superintendent, says one author, himself a superintendent of schools (20). Echoing these views, Neben cites the frequent identification of technology as the responsibility of "lower echelon educators" as a major obstacle (21).

Seidel ascribes the lack of institutional commitment in part to the "perceived self-interest of established educational institutions." Other reasons he cites include insufficient funds in schools, lack of politically powerful advocates for technology, ambiguous U.S. educational objectives, lack of computer literacy among educators, and a feeling that technology in education is simply undesirable. (11)

3.1.2.2 The Traditional Role of the Teacher

Many seem to fear that if CAI is successful, machines will nearly totally replace teachers. Much of the opposition to CAI stems from this idea, because teachers, especially in primary/secondary education, are traditionally expected to do much more than be purveyors of facts. They are role models; developers of personality; and instillers of creativity, leadership, cooperation, courtesy, self-assurance, adaptivity, and expressiveness. They are psychologists, social workers, and baby-sitters.

A computer, no matter how sophisticated, ultimately deals with right or wrong — one or zero. It is capable of subjectively analyzing a student's response only if the programmer has predicted that response. It can not go beyond wrong answers to determine their cause — e.g. parental abuse, malnutrition, drugs. It can not communicate with parents in subjective terms.

Because these are some of the manifold concerns inspired by CAI, advocates of technology do not call for full replacement of teachers by machines, no matter what the cost advantages. Instead they say that teachers should employ technology as a tool, a procedure unlikely greatly to decrease costs but with the potential for improving quality and opportunity. However, even this more limited use of technology requires major restructuring of the teacher's role. This restructuring faces its own set of barriers.

3.1.2.3 Obstacles to Restructuring the Teacher's Role; Resistance to Change in Education

The traditional teacher's role is difficult to modify. Many factors contribute; for example, training. Schools are reluctant to reorganize

and retrain staff. Few resources and little incentive exist for training (9).

Fear also contributes. Teachers and their unions fear loss of employment or reduction of the quality of their jobs to that of button pushers or clerks (9). One author claims that female teachers especially are uncomfortable with technology (20), and he notes the preponderance of women teaching in the primary grades.

Parental concern helps keep the teacher's role unchanged. Parents fear "that the little darling will not have the total attention of a mother hen for six hours a day." (20)

Teachers also are concerned about student acceptance (7) and the negative effects of removing interpersonal feedback (9). Smith cites teacher fear that technology will have a "dehumanizing effect" — that mechanized instruction will result in "automatons" (24).

Teachers have little motivation to innovate. Like other people, teachers are sometimes lazy, and they find it easier to follow the methods of <u>their</u> teachers. The usual procedures are comfortable. Why change if present methods are adequate? Present methods take less time than developing new ones — time that can be used for research, writing, consulting, or socializing.

Resistance to change is a normal psychological reaction, especially in education. Grayson states that "education has been characterized by a strong resistance to change." (24) The Committee for Economic Development states that

> the conservatism of the schools has been a natural response to society's expectation that they reflect dominant social opinion and that they perform an essentially conservative function. (17)

Bower adds that another cause exists for this recalcitrance:

> I believe there is also a strong element of self-interest and vested interest which can be rested safely on tenure (35).

3.1.2.4 Fear of Experimentation

Related to resistance to change, the fear of trying new methods has a number of causes. Made gun-shy by a number of well-publicized failures, teachers and parents fear that children will be hurt by the negative effects of experimental failure. To change substantially, schools must "develop a genuine openness to experiment and innovation," a goal made less achievable by this conservatism. (17)

3.1.2.5 The Gap Between Technologists and Educators

This infamous split is a favorite topic of writers on barriers to innovation in social services. Perhaps its popularity is due in part to the fame of C. P. Snow, who states:

> Between these two groups - the scientists and the literary intellectuals - there is little communication and, instead of fellow-feeling, something like hostility. (19)

On the one side, educators make "fallacious and disabling assumptions about technology," according to Eurich (7). He offers as examples: 1. Effective teaching must be carried on in small classes. That is, student/teacher ratio is a good indicator of the quality of instruction. 2. There is a direct correlation between what the teacher says and what the students learn. In fact, says Eurich, quality and quantity of learning depends much more strongly on the student than on the teacher and his teaching method. 3. The student learns only, or best, when he is physically in the room with the teacher. 4. There is an inverse correlation between technology in education and individual freedom (7).

This "technological backwardness," Eurich continues, has a number of causes. He cites: 1. inadequate financial support for schools; 2. the decentralization of the school system, which has slowed innovation; 3. the insulation of the world of education from outside forces — especially the lack of competition and of an accepted criterion for efficiency; and 4. teachers' feeling that technology in the classroom is improper or irrelevant. (7)

To be more specific about obstacles to the "intelligent videodisc," Seidel notes "the lack of computer literacy in potential users" and "the gap between hardware developers and educators" (1).

This last statement reminds us of the group standing on the other side of the chasm — the technologists. Seidel's survey unearthed some lack of sensitivity in this group to the problems of innovation in education; educators complained of "technology advocates pushing technology when there is no perceived need," technologist's lack of understanding of the "human aspects of education," and "inflated predictions" by advocates, leading to disenchantment.

### 3.1.3 Problems in Marketing to Education

The preceding section on attitudes of educators makes one thing clear: a salesman in this business has his work cut out for him. The people involved in marketing technology face some of the same enervating deterrents that educators who are innovators do — little incentive, little money, little interest.

The dearth of funds in nearly all institutions of learning has many causes. In higher education, fast-rising tuition can not keep pace with increasing expenses for energy, staff, and physical plant. Primary and

secondary schools, and other state-supported institutions, suffer the same rising costs on the one hand, and a general public reluctance to commit funds (11) on the other.

These tight budgets sound the death knell for technologies of high initial cost - even if they can be shown to be cost effective in the long run. This statement appears repeatedly, e.g. (9, 11, 21), as an explanation for CAI's lukewarm reception in schools. And no wonder. An administrator struggling to balance his accounts has little incentive to risk the wrath of parents and teachers by generous spending on "frills."

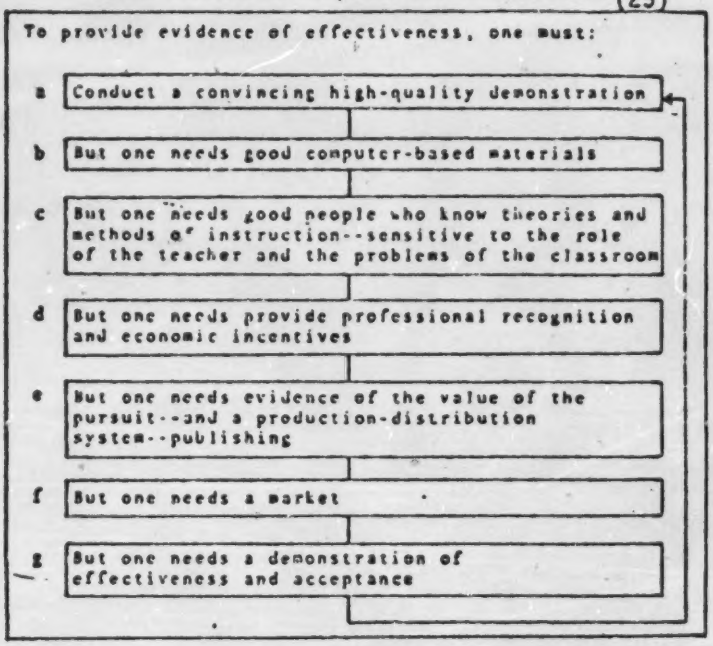
Measured against all other educational technologies, the "intelligent videodisc" is in only moderate difficulty on this account. It is not terribly expensive but it is not cheap. Therefore, careful thought must be given to marketing the device.

Turnbull, et. al., in an analysis of "diffusion" (i.e., marketing) in education, claim that innovations have failed because the developers of the product seldom appreciate the value of a commercial sales force. Developers assume that because they know a product well, they can sell it better than a salesman. This assumption may not be true. (16)

Commercial sales forces, like the rest of us, need incentives. To them, an "ideal" product is one for which orders (and commissions) repeat regularly, a workbook, for example. One of a kind items are relatively unattractive.

Another marketing issue is the value of a convincing demonstration. Anastasio (25) cites the lack of such a demonstration as a major roadblock in the path of CAI, and he makes the point well in a figure:

Figure 1. Circular Pattern of Arguments Related to the Total Problem of Computer Use in Education (25)


To provide evidence of effectiveness, one must:
a
Conduct a convincing high-quality demonstration
b
But one needs good computer-based materials
c
But one needs good people who know theories and methods of instruction--sensitive to the role of the teacher and the problems of the classroom
d
But one needs provide professional recognition and economic incentives
e
But one needs evidence of the value of the pursuit--and a production-distribution system--publishing
f
But one needs a market
g
But one needs a demonstration of effectiveness and acceptance

A "convincing" CAI demonstration, Anastasio states, is one which provides: 1. an example of use of high educational quality, 2. compelling evidence of cost effectiveness, and 3. proof that the system works in actual school settings. (9)

However, even a demonstration satisfying these criteria may not suffice. The reason may be, as Anastasio suggests, a failure to focus on high impact, low resistance markets where real institutional problems may be solved. (9) Turnbull, et. al. take this point further. They recognize that "demonstration projects" — an expenditure of federal funds to test an innovation in operational settings — "are not a panacea." Products do not sell after a successful field test unless the buyers, not just the testers, are convinced. Active experiences, not passive show and tell, are most effective. (26)

Further, they state that extensive research and development on a product, showing that it works, does not necessarily increase user demand:

> The demand for a product seems to be more a function of the appeal of the concept or the perceived utility of the product ... (26)

although, they note, the institutional prestige of the developer is often a factor.

User training also influences the fate of an innovation. Innovations which are the products of extensive research and development almost certainly will demand user training. Developers seldom recognize this fact soon enough. (26) Authors considering the unfortunate state of CAI list "lack of skilled personnel" or "technological illiteracy of educators" (11) as major obstacles.

Once users are trained, the developer is not yet home free. Users almost certainly will need help with implementation problems, and the developer must come up with incentives to retain long-term user interest. Incentives - new programs or added capabilities, for example - are a necessity because users prefer not to change their behavior patterns (26), and because they may disappear if left alone.

These general barriers confront every educational innovation. In addition, the "intelligent videodisc" presently faces other obstacles special to itself. As we shall see in our section on economic barriers, the commercial videodisc market is not yet on steady footing. The lack of a standard for design makes marketing difficult. (1, 8, 28). Moreover, intense competition from the home video tape recorder (VTR) is a certainty. Thus institutional videodisc marketing initiatives have been tentative.

MCA Disco-Vision, the producer of most notoriety, promises extensive service to institutions (27), but it has delayed entering the market (28). This author knows of only two other manufacturers actively advertising an institutional videodisc system. Telefunken is publicizing its ten-minute disc player for sale to U.S. educators through Techno Products Co., N. Hollywood, California (29). A flyer from Thomson - CSF advertises an "institutional type videodisc player." (30) Neither mentions any available programming.

### 3.1.4 Lack of Skilled Personnel and Appropriate Facilities

Few educators are good at CAI. Before the "intelligent videodisc" can be successful, we must remedy the dearth of imaginative course developers, people who are able to take full advantage of the impressive capability of the device. As Schneider notes,

> Most CAI courses have been developed as if they were to be given as class lectures, and as a result they haven't turned out to be much of an improvement ... (13)

This problem is not easily solved. Faculty must be retrained and new professionals schooled. Anastasio (9) and Finley (20) cite the federal government for the lack of teacher training programs and as a major stumbling block. Seidel expands the blame to educators themselves, pointing to their "technological illiteracy" and to "the lack of planning for personnel development to exploit new technology." He also decries the shortage of "skilled implementation personnel." (11)

Echoing this idea, the Carnegie Commission lists new professionals needed to spur development: 1. Instructional technologists, who aid faculty in defining objectives and learning strategies and in evaluating

results. 2. Media technologists, who oversee the hardware. 3. Information specialists, who find needed software resources. (1)

Once trained, however, these new professionals are likely to remain inactive unless faculty get incentives to design, develop, and revise materials. The copyright protection likely with the videodisc (which can not be pirated) is one such incentive, but in addition, the Carnegie Commission suggests that release time, instruction in the use of the technology, promotions, and salary improvements be made available to faculty involved in this activity. In the section to follow, we discuss software development further.

We note in passing that, in addition to personnel problems, at least one author cites "antiquated facilities" (20) as a major obstacle. Renovation costs to make classroom appropriate for instruction by stand-alone videodisc-CAI systems could be staggering.

### 3.1.5 Course Development

In 1972, the Carnegie Commission (1) recommended that the next decades' effort be on the development of "outstanding" instructional programs and materials. In 1977, Bork (15) stated that the lack of suitable material is still a major barrier to CAI. The thought is echoed by nearly every author who stops to wonder why progress has been so slow, e.g. (9, 11, 20, 21). Anastasio's diagram (37), reproduced in Figure 1, graphically makes clear the central importance of good, validated software.

For the "intelligent videodisc" in particular, the problem may be even more severe. To make full use of the astounding capabilities of the hardware, the course material and associated software will have to be

extremely sophisticated. Developing this sophistication will require energetic research in new software development. Using the machine's capability fully will challenge even the most talented courseware developers.

It is important to discuss why the needed CAI courseware has failed to appear despite the Carnegie Commission's charge. The literature offers explanations that fit four categories: lack of incentives, marketing problems, poor institutional mechanisms, and lack of training. As noted previously, few faculty members are granted promotions, salary increases, or release time for developing or revising CAI courseware. In addition to this lack of concrete motivation, there are strong psychological disincentives: instructional technology is far from uniformly welcomed in education, and faculty are disenchanted by the plethora of "no significant difference" research findings (1).

One way to supply incentives would be to construct new institutional mechanisms to support courseware development. By giving authors a home, their lot could be made easier; Bork says,

> So far the authors of computer-based teaching materials have had to be a hardy group, willing to perform many tasks not directly related to ... development. (15)

However, as the Carnegie Commission notes, there exists considerable uncertainty as to where to develop programming - on campus or in a national center (1). Until this decision is made, present institutions will be largely unable to handle the task. Anastasio cites the "diversity and lack of coordination of schools" and the lack of "local participation in developing CAI programs." (9)

Aggregating the market, one function that software development centers might perform, would improve the situation significantly. The

diversity of the potential market is discouraging. Seidel decries the "inability of educational institutions to standardize" as a key obstacle in developing a market for CAI courseware (11), while the Carnegie Commission criticizes the incompatibility of components used in different CAI designs. (1) Anastasio echoes this complaint and adds that poor copyright protection acts as a deterrent as well. (9) Finley notes that the educational filmstrip industry has difficulty because its schedule for development and release seldom match the lesson schedules of teachers (20).

The new "intelligent videodisc" may give us cause for hoping that the market will aggregate itself. If one standard for videodiscs is eventually chosen, and if the device is a commercial success, and if a software industry for education as well as entertainment develops, many of the aggregation difficulties will be overcome. Even the copyright problem should disappear. However, there were a lot of "ifs" in that statement. As we shall see in our section on the videodisc consumer market, much uncertainty still exists about how the issues will be resolved.

A final problem is that of training. Few faculty have the interest, the expertise in the subject matter, the familiarity with the medium, and the background in learning theory needed to develop good courseware. (1) Successful development and dissemination requires skills in instructional technology, psychology, computers, and educational administration.

### 3.1.6 Educational Research

As a key deterrent to the acceptance of innovations, Miles (19) cites the absence of valid research findings. Potential users must be convinced of the value of new systems, he says. Other authors find that extensive research is not sufficient to sell a new technique (26), but all seem to agree that it is necessary.

Causes for the current low ebb of activity in research on educational technology are as numerous as the research tasks left undone. Politics explains much of it. Government planners and politicians, reacting to general conservatism, are at best lukewarm to the idea of technology in education. Research in educational technology has no powerful advocates, and so there are no current coordinated programs to develop computer-based learning systems and materials, a lack of a critical mass of researchers, few demonstrations of the technology in educational settings, and, of course, insufficient funds (11).

Lack of money is especially critical, because the cost of the research is so high. The absence of a coordinated program is also discouraging, for it results in a lack of standards for hardware and programming, causing market disaggregation and, consequently, poor availability of courseware. Again, we face the chicken-egg problem pictured in Figure 1.

If the "intelligent videodisc" is to grow, research in educational technology must gain strength. Imposing tasks remain to be done. For example, in the opinion of many, key breakthroughs are needed in the development of new pedagogical techniques. (9) Perhaps almost all previous efforts at CAI have failed to use the computer's capability fully (11), not employing the full range of possible techniques, such as

question-answer, tutorial, drill, simulation-gaming, etc. In addition, much previous work has depended too heavily on the computer as the sole teaching mechanism, allowing for little use of other media (e.g. films) or of the human teacher.

So far we have little understanding of how best to represent ideas on the "intelligent videodisc." (11) No doubt text and lecture material will have to be completely reorganized to maximize effectiveness. (9) The task of developing effective software entails improving our poor graphic capability (8) and developing authoring systems to mix video, audio, and interaction (11). Both jobs are difficult and critical.

Two other research tasks are needed to gain a broad understanding of the effects the system might have. First, we should carry out a broad technology assessment of the impacts of the system to identify potentially unpleasant consequences of implementation and to suggest remedial policies (2). Second, we should undertake a study to account for the potential effects on the system of critical interactions in education not usually accounted for in CAI development. Interactions among the system and instructional objectives, teachers' and administrators' roles, the physical environment of the school, student motivation and background, administrative practices, and instructional processes are examples. Maximum effect can not be achieved if these variables can not be changed. (31)

### 3.2 ECONOMIC BARRIERS

This section first briefly reviews predicted costs of the "intelligent videodisc" and discusses education's likely response to them. It then considers one of the most important hurdles the technology has to

clear: a healthy consumer market for videodiscs must be born and must grow.

### 3.2.1 Costs

Hardware costs of the "intelligent videodisc" look extremely attractive when compared to those of other CAI systems. Estimates for a simple videodisc player and a color monitor cluster around $900 or so, while most authors estimate the cost of a fully interactive, "intelligent" videodisc system at between $1500 and $2000. (5, 13) Compare this estimate to one of about three hundred thousand dollars for TICCIT (32) and of twelve million or so for PLATO. (33) The new system looks very good indeed. Never mind the fact TICCIT can serve about ninety students (32) and PLATO, a thousand (33), for of primary interest to the educator is the initial system cost. Anastasio states that in the past CAI's high initial cost has been a tremendous obstacle to acceptance, even if a system could show good cost effectiveness in the long run. (9) As Miles puts it, "innovations requiring inordinate outlays of money, energy, or time ... are likely to move slowly." (19)

Comparisons of videodisc hardware costs (for the player and monitor only, not including the "intelligence") with competing display technologies also result favorably for the disc. Schneider finds that a cassette player and color TV monitor costs about $1500; a videodisc player and monitor, $900; an eight millimeter movie projector and screen, $550. (13) However, since disc replication costs are so low, for sufficient volume the per copy costs of the disc system are definitely superior. For one hundred copies of a half-hour motion visual program, Schneider finds that the 8mm projector system costs are $52.00 per copy; the 3/4-inch

videocassette, $21.25, and the videodisc, $3.01 (13). Makers of educational films have apparently made a similar calculation; they say that the videodisc will make tape obsolete, and some fear loss of film business (34). Perhaps they should. Schneider estimates that a hundred-school network using videodisc programming could save $23,000 per year over a conventional film distribution system. (13)

Ostensibly, then, cost should be no barrier to education's acceptance of the "intelligent videodisc." Correct? On the contrary, basing such a conclusion solely on a comparison of competing CAI and display system hardware costs is fallacious thinking. Two factors make it so. First, hardware costs of CAI systems may be only a small fraction of total system costs. Second, a cost comparison among CAI systems is less valid than one between the "intelligent videodisc" and present teaching methods, for these are what the system seeks to replace.

First consider software costs. "Experts familiar with [the production of] TICCIT programs," which probably are no more difficult to create than those for the "intelligent videodisc," estimate that courseware for one, full-year, college course would cost between five and seven hundred thousand dollars. (5) Clearly beyond the means of most single institutions, spending of this magnitude is only feasible if the product is widely shared. This fact seems to imply that one of two developments must occur. Either a healthy, national software production industry must come into being, stimulated perhaps by the home entertainment market, or a government-sponsored national courseware production facility must be formed. An example of the latter exists in England, where the British Open University spends "several hundred thousand dollars" to develop one of its courses (15).

Now let us make a comparison between costs for the "intelligent videodisc" and present teaching methods. Confining himself to hardware costs only, Bork estimates a charge for the standalone videodisc system of $30.00 per student per year (15). On the other side of the coin, costs of traditional teaching methods vary greatly, but some tabulated in 1971 for the teaching of reading are: teachers, $32.00 per pupil per year; films, $30.00; and paraprofessionals, $16.00. (35)

In summary, when compared to total system costs of competing CAI technologies, those of the "intelligent videodisc" are very low - so low that individual administrators could make the decision to buy without having to form consortia of school districts. On the other hand, costs are far from low enough to guarantee the sale. Moreover, courseware costs are still so high as to require wide-scale sharing – that is, a large market. For this reason, the next sections of this paper investigate the status and trends in the consumer market for videodiscs.

### 3.2.2. Problems in the Videodisc Consumer Market

Market success of the home videodisc player is far from assured. Strong competition from video cassette recorders (VCR's) and the absence of a standard disc format make manufacturers cautious and consumers lukewarm. This section studies these factors in an attempt to see where the market stands.

#### 3.2.2.1 Some General Concerns

Sometimes the most accurate assessment of a product's strong points comes from the competition. Producers of educational films and video-cassettes predict that discs will make tape obsolete in their business, citing the likelihood of fewer storage, inspection, and maintenance

problems, lower manufacturing costs, and no piracy problems. One firm, Learning Corporation of America, which will not handle tapes, says that discs are very attractive. Others fear loss of their film business. (34)

On the other hand, the competition also has a keen eye for weaknesses. Educational films today sell in quantities of about 500, and the royalties charged amount to about $30 per print. With a total price per disc of less than $10, will discs be able to recover the same $15,000 per program in royalties? If not, a negative impact of videodiscs could be that fewer educational programs are produced locally. In addition, some school districts may be concerned about the capital investment they already have in filmstrip equipment. (36)

In addition to these specialized problems, the general question of how desirable consumers find the videodisc idea has yet to be answered, since sales campaigns have not begun. Will anyone watch a feature film over and over? (37) Will videodisc's cost advantage over VCR's be offset by the capability of tape to record off the air? Will the strong 1977 sales of videotape machines reduce the market potential of discs? In an attempt to answer some of these questions, let us look at the concerns of standardization and videotape competition.

3.2.2.2 Lack of a Standard Disc Format

The list of videodisc player manufacturers is a long one, and nearly every one of them has a unique system, incompatible with everyone else's. Philips/MCA and Zenith were the only two who shared a common format, but Zenith is now out of the business (38). The MCA system works on the same principle as Thomson/CSF's: laser readout of a television signal encoded in tiny pits of varying dimension pressed into a plastic disc. (37) In contract, RCA, Mitsushita, and Telefunken players mechanically follow a groove.

Other manufacturers involved are Bosch (40), Sony, and i/o Metrics (37). These systems have received little recent publicity, however.

Performance and capabilities of the systems vary widely. One difference, of major concern to us, clearly distinguishes the optical from the mechanical readout devices. Most of the optical devices are capable of variable speed readout, freeze frame display, random access, and wear with no signal degradation. On the other hand, the mechanical devices can claim few or none of these advantages. This situation bodes ill for educational use. As Schneider puts it, "the limitations [of the mechanical players] will become intolerable to the modern educator." (13) The "intelligent videodisc," which depends on freeze frame and random access, is apparently impossible with a mechanical player.

Thus a major obstacle to the "intelligent videodisc" is the potential success of one of the mechanical players, and this possibility is still very real. The new Matsushita mechanical technology is said to allow videodiscs to be pressed with the same equipment now used to produce audio recordings, reducing mastering costs. Moreover, the device may be made compatible with RCA's player, and the RCA-Matsushita combination would be a market element of imposing strength. Indeed, the two giant corporations are already linked in VCR manufacture. (39) Another reason that mechanical players may be the ones to survive is pointed out by RCA, which has claimed that the optical disk's faster rotation speed (1800 vs 450 r.p.m.) may require horizontal synchronization circuit modifications in the receiver while RCA's slower speed would not (37).

Of the optical disc manufacturers, MCA/Philips has received the most publicity over the years, but recently the French concern Thomson-CSF has been most vigorous. Their industrial videodisc player sports a two-second

frame access time; audio compression of up to twenty seconds per video frame; built-in microprocessors, which allowed it to be tied to a CDC computer in a recent demonstration; and a capacity of 52,000 frames versus MCA's 54,000. On the other hand, the Thomson-CSF discs seem to be more fragile and the player's price may be $4,000 to $5,000. (41)

Mennie sums up the danger of this lack of standardization by writing:

> As test marketing gets under way, enthusiasm could dissipate ... because several incompatible ... systems now claim preeminence. (37)

3.2.2.3 The Videodisc's Home Market Competition

The videodisc manufacturers have more to worry about than each other. Also vying for the home video market are VCR's and video games. Moreover, cable operators and broadcasters also seek to entertain us via the "tube." The broadcasters are aware of the threat; as Wald somewhat fearfully notes:

> The effect [of videodiscs] on television will be earthshaking, since the network's corner on the dissemination of programming will be broken entirely. Independent production houses will spring up, as they have in the music business. Diversity will become rampant. (42)

If fear of this magnitude becomes widespread, broadcasters may fight the videodisc. They could wage the war with a copyright fight, much as they are doing now against the VCR (see Sect. 3.2.2.5), or they could deny permission to put their programming on discs (many broadcasters also own movie studios).

Home video games are also rivals. Households which have invested in them may be unwilling to purchase the videodisc. One game recently announced sounds in some ways very much like the "intelligent videodisc." The "Bally Home Library Computer" is microprocessor based, with games

including sound effects stored on tape cartridges, all for $299.95. A printer will be available next year. (43)

Although games and broadcasters pose definite threats, the most immediate menace is the videotape machine. Stimulated by developments in high-density recording on tape that have reduced costs (37), the home VCR market is burgeoning. One estimate holds that in mid-1976, there were 50,000 Betamaxes (the Sony VCR) in homes (44). Pre-Christmas sales in 1977 exceeded expectations, with good sales everywhere, not just in the high-income parts of town. (45) The International Tape Assocation gloated that demand was exceeding supply, and estimated that by January of 1978, 150,000 units would be in consumers' hands. (46)

A trade journal lists two possible effects of this popularity that do not bode well for the videodisc. First, competition can force a decline in costs. Second, the psychological effects of greater familiarity bred by popularity can stimulate even more VCR sales. (44) Sarnoff expands on this point, saying that

> if cassette ... prices come down, there is a good chance that there will never be a videodisc market in the United States. (47)

This strong competition from tape has had two visible effects on disc producers: they have slowed down, and one of them has begun to fight the VCRs in the courts. The next two sections review these occurrances.

### 3.2.2.4 Manufacturer Caution

Perhaps to wait and see how their VCR competitors will fare, at least three of the major disc manufacturers slipped schedules, slowed work, or pulled out altogether in 1977. Zenith is out (38), RCA has cut its disc workforce by 60% (48), and Philips/MCA has announced delays (49).

The MCA story is the most interesting. In mid-March, 1977, optimism was still strong, with Videonews claiming that "marketplace entry of the MCA videodisc will take place in December (1977)." (50) However, by the end of March, that optimism was fading. Finding MCA executives non-committal about an introduction date for their institutional system, Videonews complained:

> if MCA's industrial disc is everything the firm says it is, ... then a potential mass market is obvious. Yet ... for the moment MCA wants just to sell some prototypes. That ... tends to add to the impression that it will be a good many months ... before the industrial disc player is here in any quantity. (28)

By October of 1977, MCA itself was admitting to the delay, saying that it would take until late fall of 1978 for MCA/Philips Disco-Vision to come to market. Company executives claimed that "MCA ... [had] developed a system to use both sides of the disc" to double play time, and that the modification necessitated the delay. Videonews speculated that in fact "the delay [was] a wait and see period while the home videotape market goes through its shakeout period." (49)

The most recent sign of caution was the mid-November, 1977 Videodisc/Home Video conference, at which MCA, RCA, and others had no displays. Videonews saw it "as evidence that the home videodisc is still unlikely to be a market reality in the near future." (38) A VCR manufacturer at the meeting commented that:

> [disc] manufacturer indecision about playing time, difficulty in competing with VCR prices, and servicing problems have all been obstacles to disc marketing. (38)

Compared with MCA, RCA was decisive. In August, 1977, RCA cut from 250 to 100 the number of employees involved in prototype work (51). Ruark speculated that the reasons for the pullback were: 1. a desire for

compatibility with Matsushita, 2. the need for information system capabilities (e.g. random access, variable playback speeds, etc.) to compete with the now-established VCR market, and 3. a decision to wait for the outcome of the Sony-MCA copyright suit (see below). (48)

It is well to note that, bleak though the portents of these actions may seem, there have been a few positive indications from the market. Videonews reported in November, 1977 that an MCA manager had said, "MCA continues to have a clear and firm commitment to introduce the product into the market" with a test planned in the fall of 1978. (47) In addition, some glimmers of hope for education: in March, 1977, the company announced an agreement with a consortium of Washington area universities to develop college-level courses formatted for the videodisc (28). Another educational institution has also showed interest; the University of Illinois stated its desire to take over the Zenith videodisc operation and develop the system for educational use (38).

3.2.2.5 The Copyright Battle

The copyright issue may be the videodisc's trump card in its quest for a home market. Despite this fact, we discuss the topic here in a "barriers" section because it is evidence of the intense videodisc - VCR competition.

MCA-Universal and Walt Disney Studios are suing Sony and four (52) consumer defendants who are individual Betamax VCR owners. The suit is an attempt to get the courts to enjoin individuals from taping copyrighted television material off the air. Sony's counterclaim is essentially that no one can dictate what the private citizen does with electronic devices in his/her own home (42).

The suit, whose hearing has been delayed until May, 1978 (52), will be tried under the new Copyright Act. The Act specifies three grounds for alleging copyright infringement: a copyright gives its owner exclusive right to 1. copy the work, 2. perform it publicly, and 3. make a "record" of it that is performed. However, in the past, a defense called the "fair use" doctrine has been used effectively, and the new act codifies this doctrine. Under "fair use," the copyright owner's rights do not apply in certain cases, depending on: 1. the purpose of the use (some say private use is always fair), 2. the nature of the work (if the copyright owner's livelihood depends on having the sole copy of a work, other use may be unfair), 3. the amount copied (for VCRs, this is the entire work - possibly "unfair"), and the effect on the owner's market. (53)

The four "fair use" factors show that VCR producers and users have enough legal ammunition on their side to make the outcome anyone's guess. Thus, Videonews suggests that

> any manufacturers, retailers, or software producers who've been confidently betting on one outcome or the other would do well to hedge those bets. (53).

## 3.3 TECHNICAL OBSTACLES

This brief section lists some engineering problems to be solved before the "intelligent videodisc" can be used in education. Most of the problems already appear in the last two "barriers" sections in their "education" or "economic" context, but we bring them together here to summarize. We highlight three concerns: man-machine communication, reliability, and standardization.

Research is necessary to develop convenient means of communicating with the "intelligent videodisc." Three types of communication are

involved: first, developing an authoring language that permits the creator of courseware conveniently to mix the system's many modes of operation: motion video, stills, audio, and interactive CAI. Second, creating read/write capabilities (e.g. on a magnetic area of the disc) for interaction and record keeping. Third, designing a good user-machine interface. (9, 11)

Of these three types of communication, perhaps the most critical is the third. The success of user-machine interface depends on a number of factors, including the type of input permitted. Present CAI systems all limit the variety of student inputs to some degree. A slight deviation from expected format, a mischance in phrasing, and the machine and its luckless pupil part ways. Expanding the range of possible inputs could cause the interaction to flow more freely. (9)

A second way to aid the flow between man and machine is in the language that student and computer use to communicate. The more comfortable the student is with this language the better.

A final element of the man-machine interface is mechanical. Questions arise such as: is there a way to enhance the convenience of the typewriter input, especially for youngsters? Which is better for interaction, the "touch sensitive" terminal screen, a joystick, or a ball and cursor?

In addition to communication, reliability is a major area of concern. (9) Teachers and students will have little patience with, or desire to use, a system that often grinds to a halt in mid-lesson. Both hardware and software reliability are involved. The opposing optical and mechanical camps of disc manufacturers each warn of the other's possible hardware reliability weaknesses - problems such as fragile discs, wear,

and player-receiver synchronization. (37) The creation of "bug"-free software, a problem wherever computers are used, is especially critical when users are unfamiliar with and unforgiving of computers. Witness, for example, the hostility that arises when a customer finds computer error on his credit card bill.

A final key technical problem is the standardization question already discussed. The lack of a set standard for the videodisc deters development and turns aside potential buyers. (9, 11)

## 4. DETERMINANTS OF SUCCESS IN EDUCATIONAL TECHNOLOGY*

After our long and somewhat depressing discussion of barriers to the "intelligent videodisc," let us consider success. This section points out some factors which differentiate successful educational technology projects from unsuccessful ones. Thus, the section can be read either as a summary or as a preliminary list of recommendations.

Apparently, a project's fate is largely determined before installing the equipment. Careful planning and problem identification must come before implementation of any instructional technology. Unless objectives are well-defined, the equipment's potential is rarely fully realized. As Schramm, et. al. point out:

> The probability of success is greater if a project grows out of a critical appraisal of needs and alternative solutions, represents an alternative of feasible size, and is supported by the allocation of adequate financial resources. (54)

David Ahl agrees:

> ... the new technological solutions must meet the needs of the educator as he perceives them himself. Even though technology may solve a real and very legitimate problem faced by educational institutions it will not be adapted unless the educator sees the problem clearly and has assigned a high priority to its solution. (55)

Intensive faculty and administrative involvement at all decision making stages also appears repeatedly in successful operations. "Teacher resistance," a barrier we cited often, can be reduced by allowing teachers a role in or responsibility for the new system. Given this involvement,

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*The author acknowledges his student, Ms. Debby Wallace, whose work in a paper for the author's course contributed substantially to this section.

they are more likely to participate actively. Moreover, as we emphasized, administrators play at least as central a role. As Schramm, et. al., state:

> The probability of success is also greater if a project has strong support from top authority, unity of purpose among authorities responsible, and broad involvement within the educational system in the new project. (54)

While Jackson, writing about less successful trials of educational technology, complains that

> Thus far the involvement of classroom teachers in the development of new instructional devices has been minimal ... If these devices are to be used imaginatively in the classroom a rapprochement between producers, administrators, and teachers is required. Teachers must no longer be viewed as a group to be sold on the benefits of the new techniques, as customers, so to speak. They must be viewed instead as partners in the development of the modern classroom. (56)

Also of paramount importance is a testing period which allows teachers to get "hands on" involvement with the new technology before a commitment is made to use it. The test can put teachers at ease, and it can allow them to experiment.

A final element of successful innovation is long-term and dependable financial support. Adequate resources allow work to proceed smoothly, without the problems that can arise from equipment of inferior quality or lack of personnel. The need to provide these resources reemphasizes the need for careful planning before implementation. Unanticipated costs can ruin any project.

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